PART B

PATTERN CONTROL OF HORN ANTENNAS

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I. Tasks Accomplished

During this period, the computations of the impedance elements have been completed. These include interactions between the two electric current modes, the electric current mode and the magnetic current mode, and the two magnetic current modes. Especially, an accurate and efficient formulation of computing interactions between electric current mode and magnetic current mode has been accomplished. This, together with other subroutines we have developed, enables us to fill-in all the elememt in the matrix.

After the fill-in of the impedance elements in the matrix, the forward problem is accomplished. That is, given the specification of the horn and the excitating waveguide mode, the radiation pattern of the antenna based on the integral equation can be obtained.

An example case was run for a standard X-band gain-horn (DBG-520) with the configuration in Figure 1. The H- and E-plane patterns of this horn antenna with perfectly conducting walls are shown respectively in Figures 2 and 3. Comparison with the gain pattern available from the manufacturer for up to the first side lobe shows

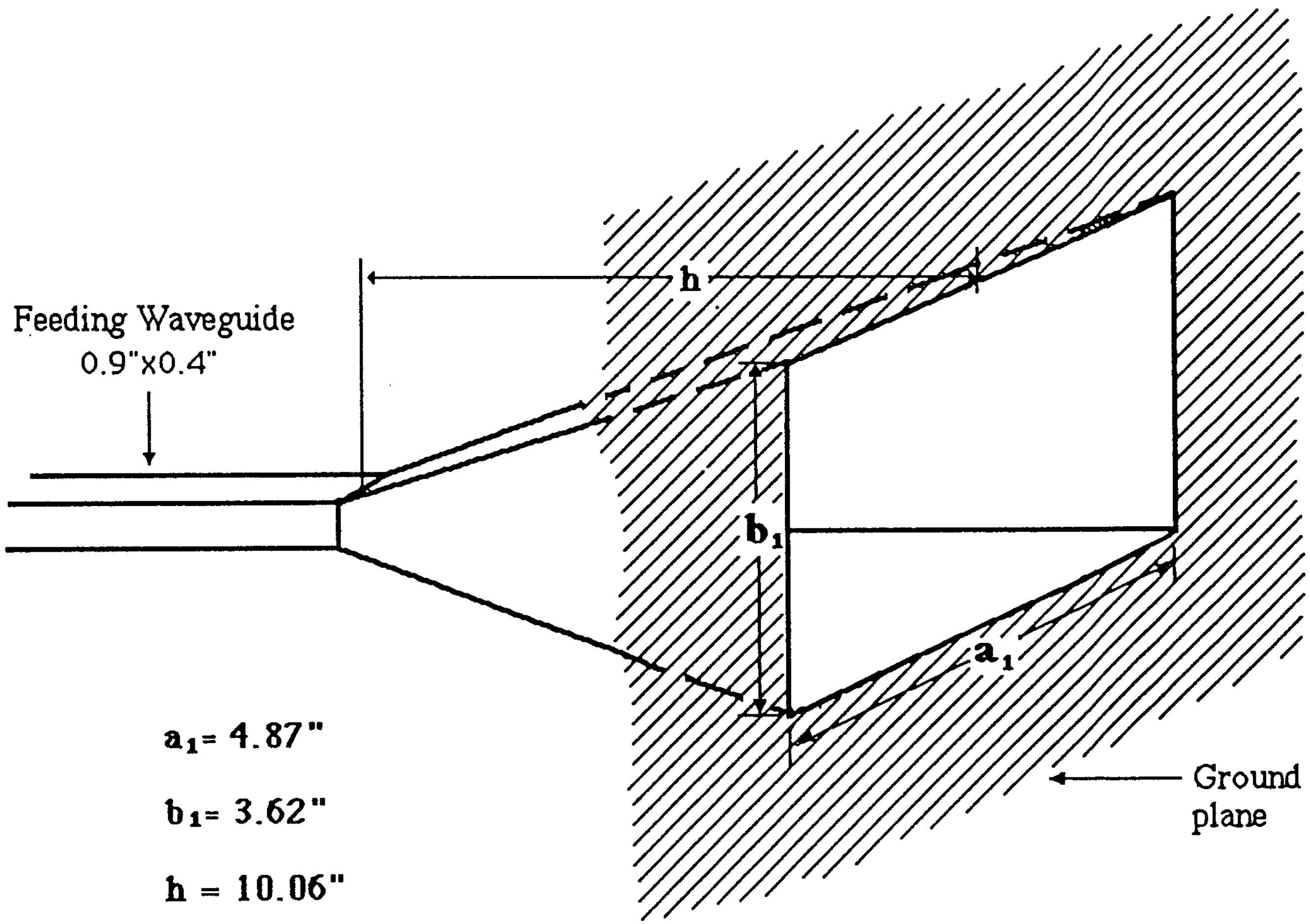

Figure 1. Geometry of the X-band horn (20dB gain, Model DBG-520)

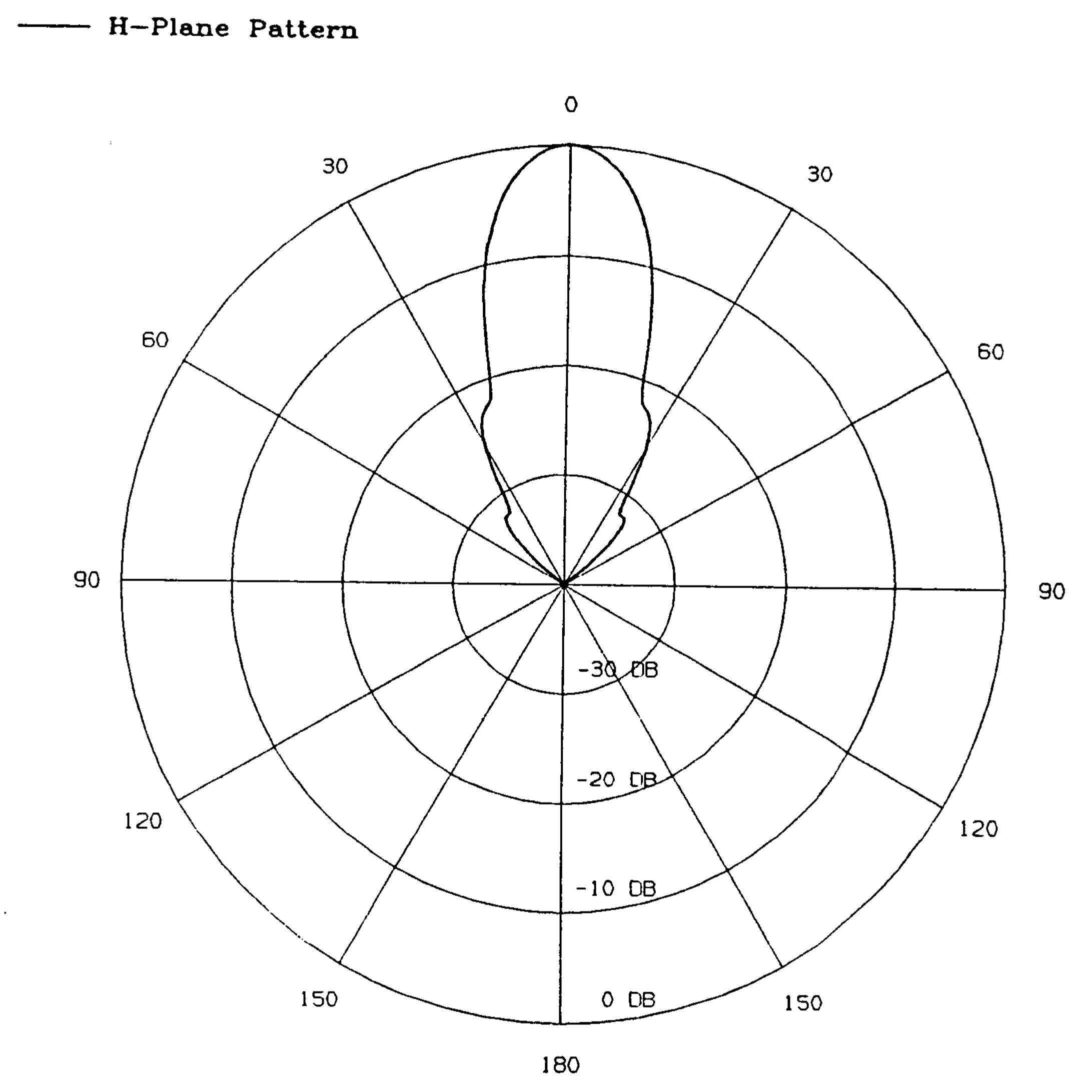

Figure 2. Normalized amplitude pattern for 20dB gain horn antenna (DBG–520) with perfectly conducting electric walls (f = 10 GHz).

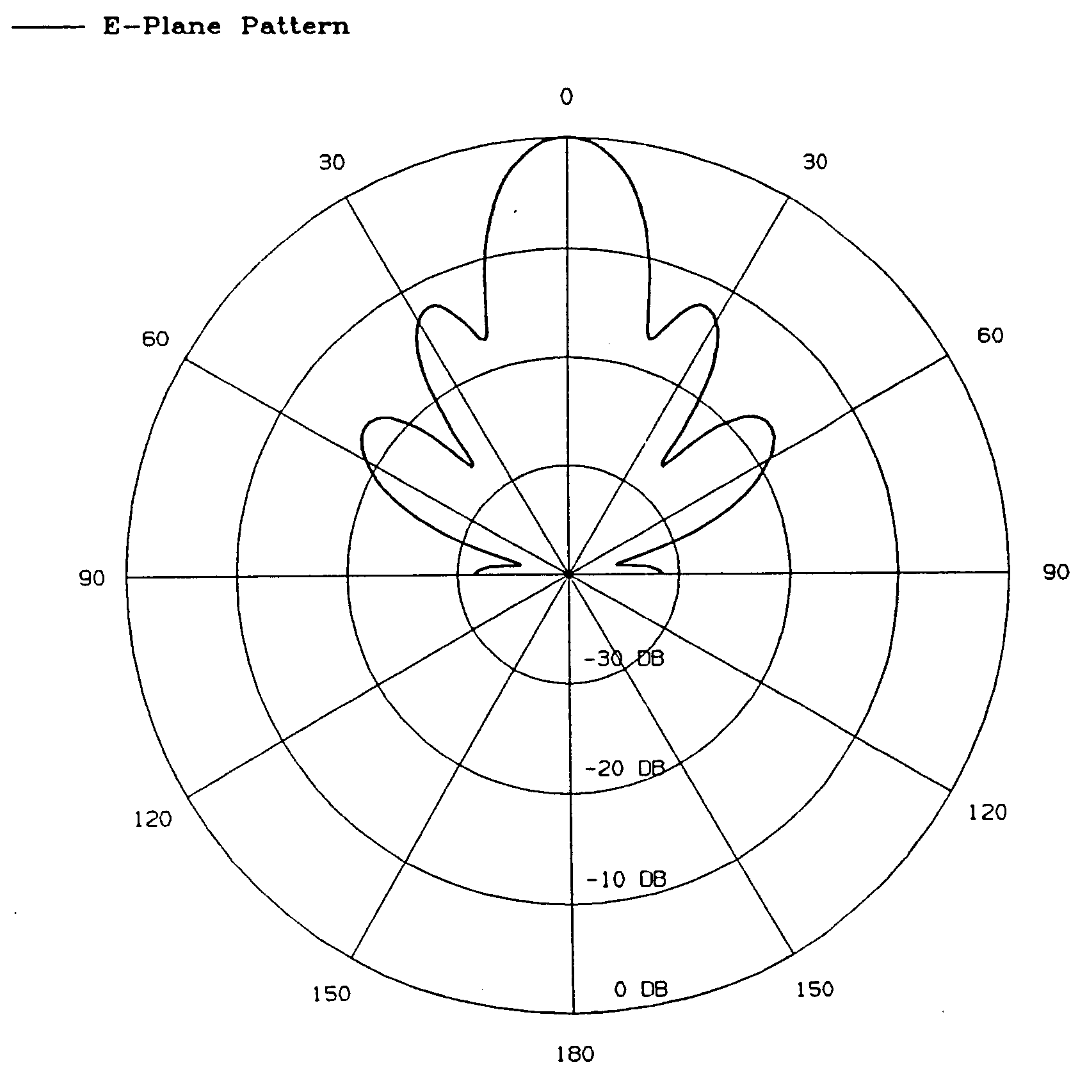

Figure 3. Normalized amplitude pattern for 20dB gain horn antenna (DBG–520) with perfectly conducting electric walls (f = 10 GHz).

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good agreements, although the cross polarization has not yet been accounted for.

To investigate the effect of the lossy coating on the radiation pattern, two sets of the lossy materials were used to cover the top and bottom walls of the horn. This is intended to improve the E-plane pattern. The plots shown in Figures 4 and 5 are obtained by uniformly covering the top and bottom walls with a layer of AlSb with a thickness of $0.001\lambda_o$ (3×10^{-5} meters). The material has a relative dielectric constant of 11 and a resistivity of 0.005 $\Omega \cdot$m. The resulting E-plane pattern shows about 2-dB improvement in the sidelobes. Figure 6 and Figure 7 are obtained based on a material which has a relative dielectric constant of 3 and a sheet resistance of 1500 Ω per square. The thickness of this material is 2 mils (5.08 $\times 10^{-5}$ meters). The resulting E-plane pattern shows about 3-dB improvement in the first sidelobe and 4-dB improvement in the second sidelobe.

Further improvement can be expected by increasing the thickness of the coating. However, the validity of our impedance boundary condition becomes questionable. A better impedance condition has been developed; however it has not yet been implemented in the computer program.

In the moment method solution of this project, the computations of the matrix elements are the most tedious part of the work. We have

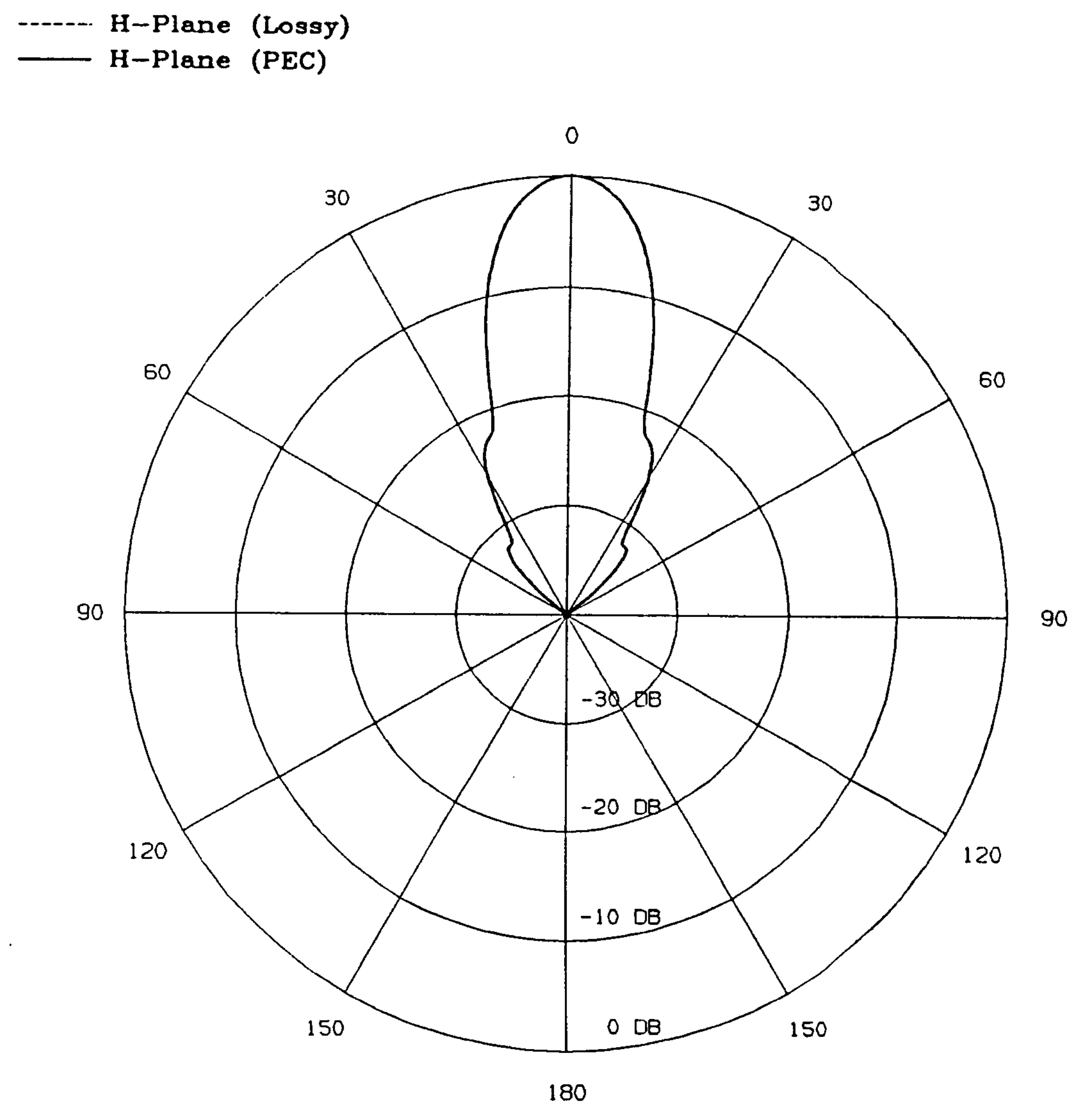

Figure 4. Normalized amplitude pattern for 20dB gain-horn antenna (DBG-520) with upper and lower walls covered with AlSb (f = 10 GHz).

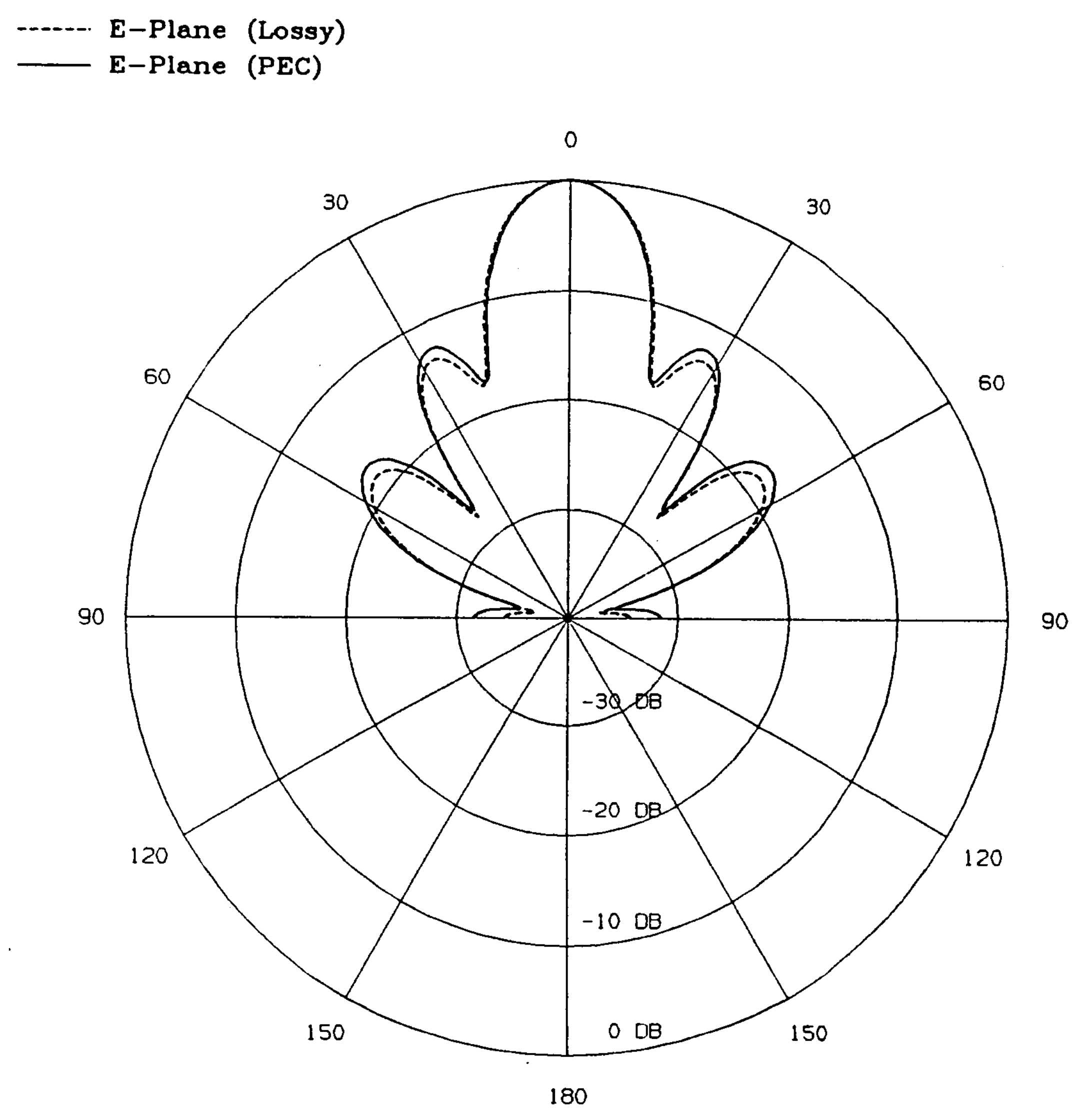

Figure 5. Normalized amplitude pattern for 20dB gain-horn antenna (DBG-520) with upper and lower walls covered with AlSb (f = 10 GHz).

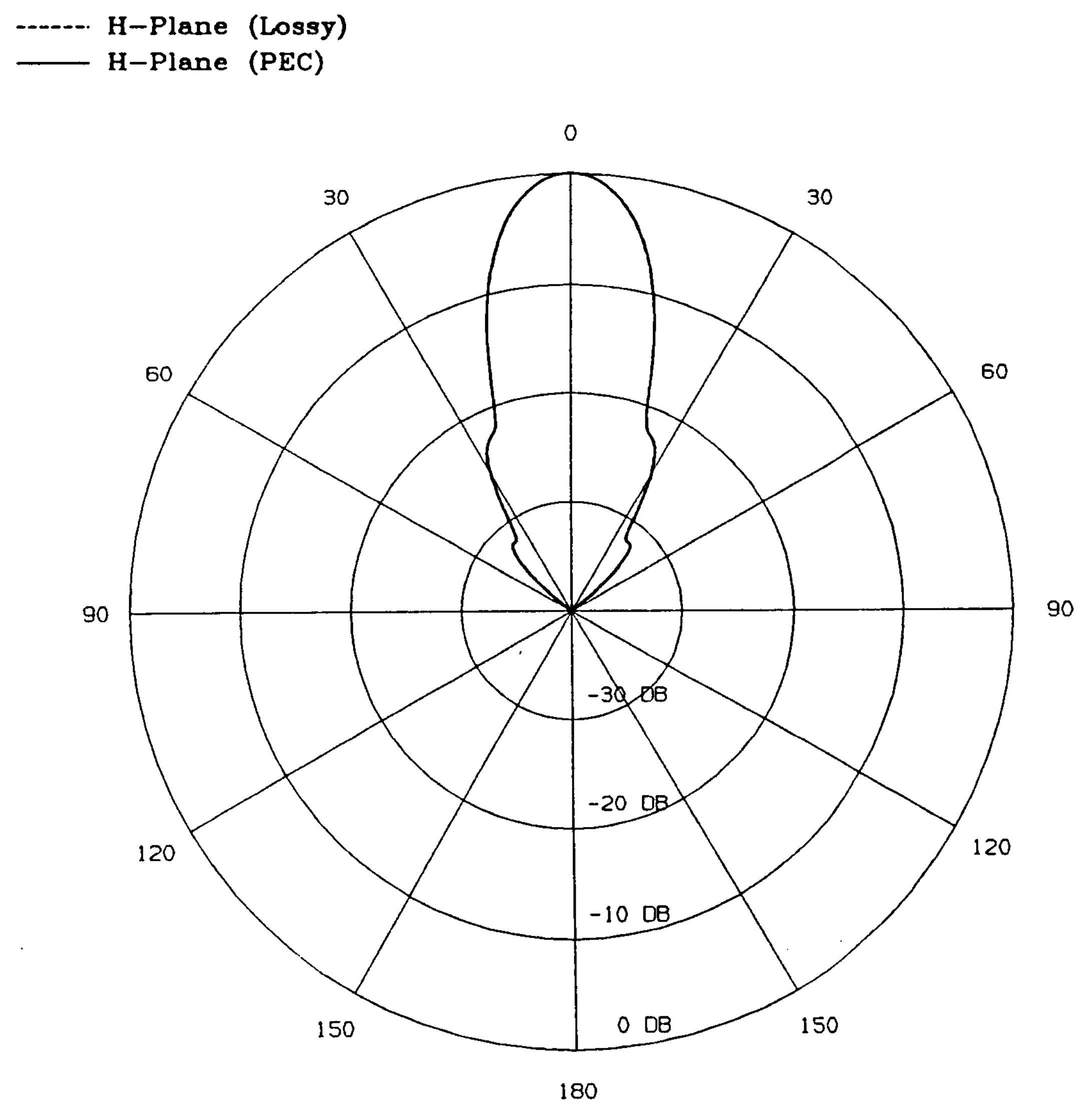

Figure 6. Normalized amplitude pattern for 20dB gain-horn antenna (DBG-520) with upper and lower walls covered with lossy material (f = 10 GHz).

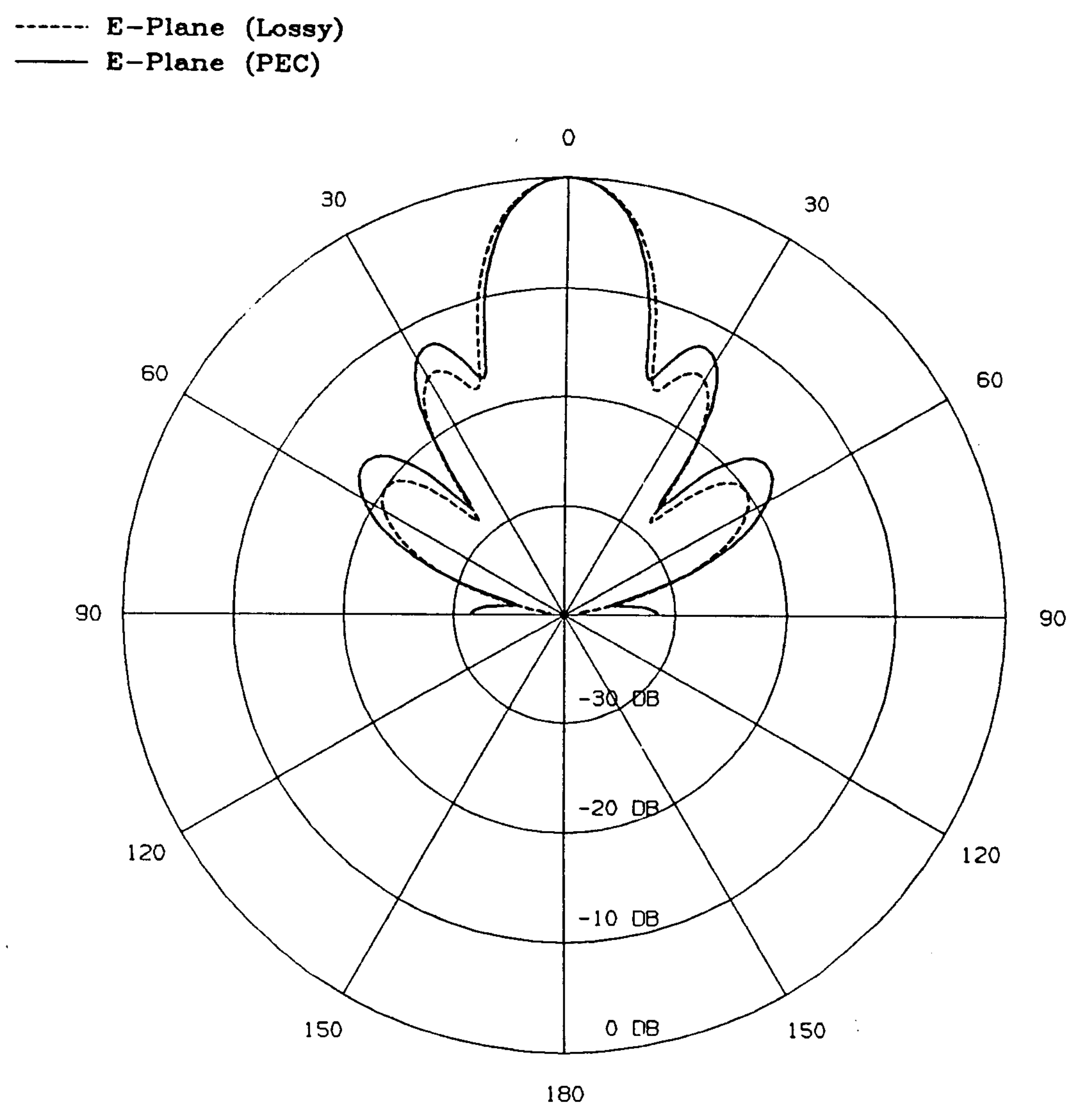

Figure 7. Normalized amplitude pattern for 20dB gain-horn antenna (DBG-520) with upper and lower walls covered with lossy material (f = 10 GHz).

basically fullfilled this task. Although we still did not have time to connect all parts of the work together to realize the synthesis problem, we can say we are progressing well toward that goal.

II. Future Work

Future work will be concentrated on the following items:

1. To include the cross polarization components of the equivalent magnetic currents on the two appertures.
2. To compare this integral equation method with another rigorous method by H. Patzelt and F. Arndt [1].
3 To investigate the realization of the sheet impedance needed to control the radiation pattern, and to extensively verify the validity of the impedance boundary condition.
4. To reassemble the matrix equation to solve the synthesis problem as was presented in the previous report.

REFERENCES

1. Hartmut Patzelt and Fritz Arndt, "Double-plane steps in rectangular waveguide and their application for transformers, Irises, and filters," *IEEE Trans.* Microwave Theory Tech., vol. MTT-30, pp.771-776, May, 1982.